

## CLAIMS

1           1. A traffic shaper for use in determining transmission start times for network  
2 messages, the traffic shaper comprising:  
3           a plurality of queues for storing information relating to the network messages;  
4           a queue controller operably coupled to the plurality of queues for storing the in-  
5 formation in and retrieving the information from the plurality of queues;  
6           a scheduler in communicating relationship with the queue controller, the sched-  
7 uler configured to compute release times for the network messages;  
8           a memory for storing the computed release times; and  
9           a memory controller operably coupled to the memory, the memory controller con-  
10 figured to search the memory for computed release times,  
11           wherein release times are computed and stored in the memory as information re-  
12 lating to the network messages is retrieved from the queues.

1           2. The traffic shaper of claim 1 wherein the information includes a network mes-  
2 sage length and a network message pointer.

1           3. The traffic shaper of claim 1 wherein each network message is associated with  
2 a shaper identification (SID) value, and the traffic shaper further comprises a queue con-  
3 trol memory accessible by the queue controller, the queue control memory including a  
4 mapping of SID values to queues such that the information for a given network message  
5 is mapped by the SID value associated with the given message to a specific queue.

1           4. The traffic shaper of claim 3 wherein the queue control memory further in-  
2 cludes data for each queue indicating whether the respective queue is empty.

1           5. The traffic shaper of claim 4 wherein the scheduler comprises a rate monitor  
2 configured to determine a rate at which network messages can be released, and a release  
3 timestamp generator for computing release times based on the determined rates.

1           6. The traffic shaper of claim 5 wherein the determined network message release  
2 rates are one of Committed Information Rate (CIR) and Excess Information Rate (EIR)  
3 values.

1           7. The traffic shaper of claim wherein the memory comprises at least one content  
2 addressable memory structure for storing computed release times, and corresponding a  
3 random access memory structure for storing the SID values associated with the respective  
4 release times stored in the content addressable memory structure.

1           8. The traffic shaper of claim 7 wherein the memory controller comprises a re-  
2 trieve time generator for producing retrieve times that are used to search the computed  
3 release times stored in the content addressable memory structure.

1           9. The traffic shaper of claim 8 further comprising a current time generator for  
2 producing a current time, wherein the retrieve time produced by the retrieve time gen-  
3 erator can catch up to but not exceed the current time produced by the current time gen-  
4 erator.

1           10. The traffic shaper of claim 9 wherein upon identifying a release time stored in  
2 the content addressable memory that matches the release time produced by the release  
3 time generator, the memory controller provides the SID value associated with the  
4 matching release time and the current time to the queue controller.

1           11. The traffic shaper of claim 10 wherein the queue controller, upon receiving a  
2 SID value from the memory controller, accesses the queue control memory to identify the  
3 queue corresponding to the received SID value, and retrieves the information from the  
4 head of identified queue, thereby releasing the corresponding network message from the  
5 traffic shaper.

1           12. The traffic shaper of claim 1 configured to support multiple levels of shaping.

1           13. A method for shaping network traffic by selectively releasing network mes-  
2 sages, the method comprising the steps of:  
3           providing a plurality of queues for storing data;  
4           associating each queue with a corresponding shaper identification (SID) value;  
5           receiving information related to a network message to be shaped, including a SID  
6 value;  
7           storing at least some of the received information at the queue corresponding to the  
8 received SID value;  
9           computing a release time for each queue containing network message informa-  
10 tion;  
11           storing the computed release times in a time-searchable memory structure; and  
12           upon expiration of a computed release time, dequeuing network message infor-  
13 mation from the queue corresponding to the expired release time.

1           14. The method of claim 13 wherein a new release time is computed for a given  
2 queue in response to the step of dequeuing network message information from the given  
3 queue.

1           15. The method of claim 14 further comprising the step of searching the time  
2 searchable memory structure for expired release times.

1           16. The method of claim 15 wherein the network message information stored at  
2 the queues includes a message length and a message pointer.

1           17. The method of claim 14 further comprising the steps of:  
2           associating each computed release time stored in the time-searchable memory  
3 structure with a corresponding SID value; and  
4           upon expiration of a computed release time stored in the time-searchable memory  
5 structure, using the associated SID value to identify the queue from which network mes-  
6 sage information is to be dequeued.

1           18. The method of claim 17 wherein the step of computing a release time com-  
2       prises the steps of:  
3           determining, based on a rate at which network messages are being drained,  
4       whether an excess information rate (EIR) or a committed information rate (CIR) is to be  
5       used in the calculation; and  
6           computing the release time based on the EIR or CIR as determined.

1           19. The method of claim 18 wherein the step of determining comprises the steps  
2       of:  
3           computing a level at which network messages are draining from the respective  
4       queue;  
5           comparing the level to a threshold;  
6           if the new last updated level exceeds the threshold, selecting the CIR; and  
7           if the new last updated level does not exceed the threshold, selecting the EIR.

1           20. The method of claim 19 further comprising the step of, upon dequeuing net-  
2       work message information from a first queue in response to an expired release time, en-  
3       queuing the network message information at a second queue.

1           21. A traffic shaper for use in determining transmission start times for network  
2       messages, the traffic shaper comprising:  
3           a plurality of queues for storing information relating to the network messages;  
4           means for storing the information in and retrieving the information from the plu-  
5       rality of queues;  
6           means for computing release times for the network messages;  
7           a memory for storing the computed release times; and  
8           means for searching the memory for computed release times,  
9           wherein release times are computed and stored in the memory as information re-  
10       lating to the network messages is retrieved from the queues.

1           22. The traffic shaper of claim 21 wherein the release time computing means  
2 comprises means for determining a rate at which network messages can be released, and  
3 the release time computing means computes release times based on the determined rates.

1           23. The traffic shaper of claim 22 wherein the searching means comprises means  
2 for producing retrieve times that are used to search the computed release times stored in  
3 the memory.

1           24. The traffic shaper of claim 23 further comprising means for generating a cur-  
2 rent time, wherein the retrieve time from the retrieve time producing means can catch up  
3 to but not exceed the current time produced by the current time generator.

1           25. A computer readable medium containing executable program instructions for  
2 shaping network traffic by selectively releasing network messages, the executable pro-  
3 gram instructions comprising program instructions for:  
4           providing a plurality of queues for storing data;  
5           associating each queue with a corresponding shaper identification (SID) value;  
6           receiving information related to a network message to be shaped, including a SID  
7 value;  
8           storing at least some of the received information at the queue corresponding to the  
9 received SID value;  
10          computing a release time for each queue containing network message informa-  
11 tion;  
12          storing the computed release times in a time-searchable memory structure; and  
13          upon expiration of a computed release time, dequeuing network message infor-  
14 mation from the queue corresponding to the expired release time.

1           26. The computer readable medium of claim 13 wherein a new release time is  
2 computed for a given queue in response to the step of dequeuing network message infor-  
3 mation from the given queue.

1           27. The computer readable medium of claim 14 further comprising programming  
2 instructions for searching the time searchable memory structure for expired release times.

1           28. The computer readable medium of claim 15 wherein the network message in-  
2 formation stored at the queues includes a message length and a message pointer.

1           29. The computer readable medium of claim 14 further comprising programming  
2 steps for:

3           associating each computed release time stored in the time-searchable memory  
4 structure with a corresponding SID value; and

5           upon expiration of a computed release time stored in the time-searchable memory  
6 structure, using the associated SID value to identify the queue from which network mes-  
7 sage information is to be dequeued.

1           30. The computer readable medium of claim 29 wherein the programming in-  
2 struction for computing a release time comprises programming instructions for:

3           determining, based on a rate at which network messages are being drained,  
4 whether an excess information rate (EIR) or a committed information rate (CIR) is to be  
5 used in the calculation; and

6           computing the release time based on the EIR or CIR as determined.

1           31. The computer readable medium of claim 30 wherein the programming in-  
2 structions for determining comprises the programming instructions for:

3           computing a level at which network messages are draining from the respective  
4 queue;

5           comparing the level to a threshold;

6           if the new last updated level exceeds the threshold, selecting the CIR; and

7           if the new last updated level does not exceed the threshold, selecting the EIR.

1           32. The computer readable medium of claim 31 further comprising programming  
2 instructions for, upon dequeuing network message information from a first queue in re-

- 3     sponse to an expired release time, enqueueing the network message information at a sec-  
4     ond queue.